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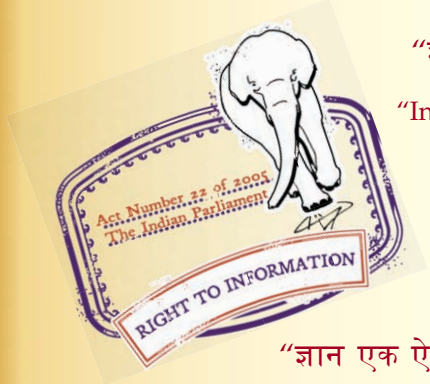
IS 11495 (1986): Code for design of surface farm drainage system [FAD 17: Farm Irrigation and Drainage Systems]



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"Invent a New India Using Knowledge"

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 11495 - 1986
(Reaffirmed 2000)

Indian Standard

CODE FOR DESIGN OF SURFACE FARM DRAINAGE SYSTEM

UDC 631·62

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

May 1986

Indian Standard

CODE FOR DESIGN OF SURFACE FARM DRAINAGE SYSTEM

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Indian Standard

CODE FOR DESIGN OF SURFACE FARM DRAINAGE SYSTEM

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 31 January 1986, after the draft finalized by the Farm Drainage Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 Surface drainage system design criteria are based on the assumption that all lands to be drained will be suitable for agricultural use after drainage. Design shall consider construction and maintenance needs and irrigation requirements where applicable. The rate of water removal, in terms of depth per unit of time, to be provided by the drainage system depends on several inter related factors, such as rainfall characteristics, soil properties and cropping patterns. For most row crops, surface drainage system are able to provide complete removal of excess water from the soil surface within 24 hours after rainfall ceases.

0.3 While formulating IS : 11494-1986*, a need was felt to prepare an Indian Standard indicating the guidelines for designing the surface drainage system. This standard is intended to fulfil this need.

0.4 In preparation of this standard, assistance has been derived from ASAE EP 302.2-1973 'Design and construction of surface drainage systems on farms in humid areas', issued by American Society of Agricultural Engineers, USA.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†.

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1. SCOPE

1.1 This standard provides guidelines for designing of surface farm drainage system.

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*Code for construction and maintenance of surface farm drainage systems.
†Rules for rounding off numerical values (*revised*).

2. GENERAL

2.1 The intensity of drainage desired is expressed in terms of drainage curve. These curves are developed from a large number of field measurements of drainage flow rates and observations of adequacy of drainage. Excess run off will be discharged as overland flow temporarily flooding adjacent lands.

3. DITCH DESIGN

3.1 Field drains are located at the lower ends of field rows, through surface depressions, above barriers that trap run off, and where required to divert run off from lower areas. Drains located at or near soil changes provide locations for field roads, permitting the soils to be managed differently during farming operations. Field drains need not be designed to contain the quantities of flow indicated on the drainage curves, as their primary purpose is to remove residual surface water after volume run off has passed out of the field. Recommended design grades are from 0·10 to 0·30 percent, and should never be less than 0·05 percent. Grades may be uniform or may increase or decrease. Abrupt changes to flatter grades may result in excessive sedimentation. Recommended dimensions of drains are given in Table 1 (*see also* Fig. 1) for guidance.

TABLE 1 RECOMMENDED DIMENSIONS OF ROW DRAIN AND FIELD DRAIN

Sl No.	Type	Depth m	Bottom Width m	Side Slope H : V*
(1)	(2)	(3)	(4)	(5)
i)	Row drain	0·09†	0	—
ii)	Vee	0·15 to 0·3	0	10 : 1 or flatter†
iii)	One-half vee	0·15 to 0·3	—	15 : 1 or flatter
iv)	Trapezoidal	0·23 to 0·45	2·4	8 : 1 or flatter

*Horizontal : Vertical.
†Minimum, 0·06 m below row middles for row crops.

3.1.1 Row drains are acceptable field drains provided they have adequate grade and topography permits the disposal of spoil without restricting drainage into the row drains as well as adequate maintenance is provided.

3.1.2 Vee field drains with side slopes steeper than 10 : 1 are easily constructed and maintained with blade equipment. These drains are difficult to cross with farm machinery, fill rapidly with sediment, and must be re-established yearly. They are not recommended under normal conditions.

3.1.3 Vee field drains, that are 0·15 to 0·3 m deep with 10 : 1 or flatter side slopes, are excellent when crop rows on one or both sides terminate at or near the centres of the drains. Field roads adjacent to these field drains will not interfere with mechanized operations if field road side slopes are not steeper than 10 : 1.

3.1.4 One-half vee field drains are not crossed by farm machinery. Machinery turns within the cross sections without crossing the bottoms of the drains. Turn areas must be smooth and any obstructions at the bottoms of the drains removed. There are no restrictions on the side slope opposite the field other than that it must be stable.

3.1.5 Trapezoidal field drains are satisfactory in some areas. Where soils are not erosive, trapezoidal field drains can be constructed to grade without uniform depths and can be expected to have long lives with little maintenance. Where soils are erosive and field drains are not vegetated, trapezoidal field drains with the recommended depths will fill quickly with eroded material.

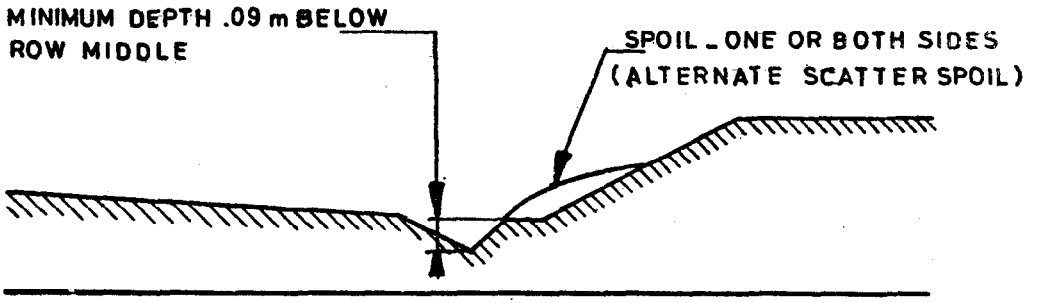
3.1.6 Double field drains are recommended only on ungraded land for use in wide and shallow depressions where run off enters from both sides and the excavated soil must be placed between the twin drains, Recommended minimum distance between the centre lines of the twin field drains is 15 m for drains 0·15 m deep, plus 3 m for each additional 0·03 m of depth. Lesser distances may be necessary at the outlet ends because of construction requirements.

3.2 Subsurface drains are located adjacent to field drains in some areas where subsurface drainage is effective. The installation of subsurface drains lowers water tables, aids tillage and reduces maintenance requirements.

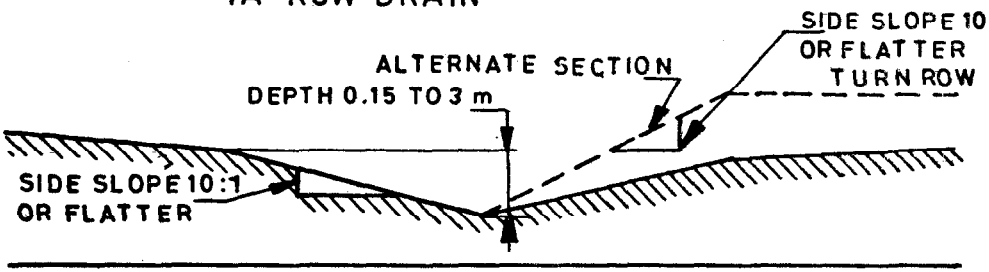
3.3 Field laterals shall be designed to discharge the rates of flow indicated by the appropriate drainage curves. Field laterals occupy productive land and are costly to construct and maintain. They shall be spaced as widely apart as field conditions permit. Recommended dimensions of field laterals are given in Table 2 (*see also* Fig. 2) for guidance.

3.3.1 The design cross sections of field laterals shall meet the combined requirements for capacities, erosion control, depths, side slopes, maintenance and, if needed, allowance for sedimentation. Minimum field lateral depths, regardless of design capacities, shall be 0·3 m.

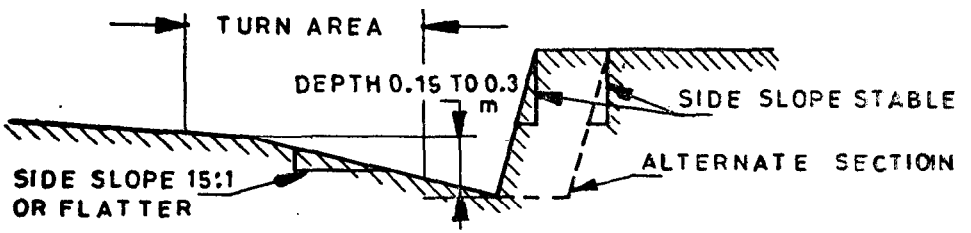
3.3.2 The water surface elevations used in the design of field laterals shall be as near natural ground surfaces as practical to hold ditch depths to a minimum at row drain and field drain entrances. Flat side slopes and, for trapezoidal sections, wide bottom widths can be used to reduce depths.



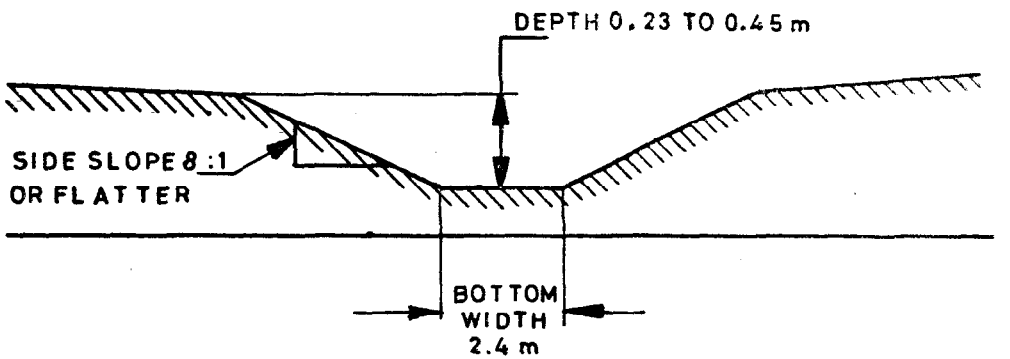
1A ROW DRAIN



1B VEE FIELD DRAIN

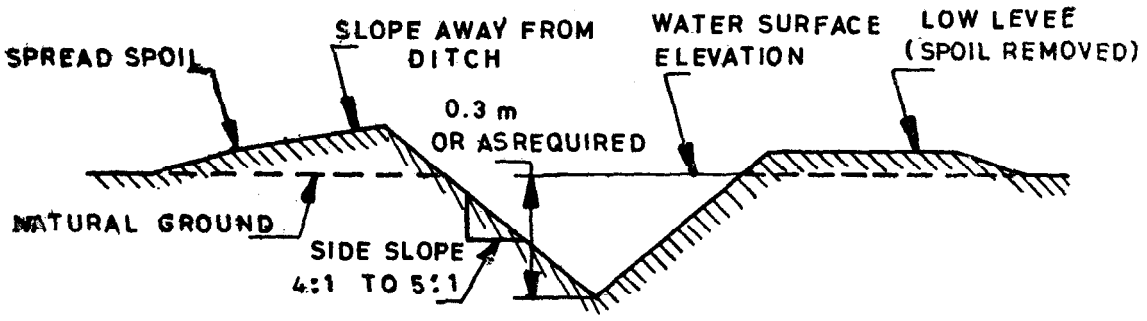


1C HALF-VEE FIELD DRAIN

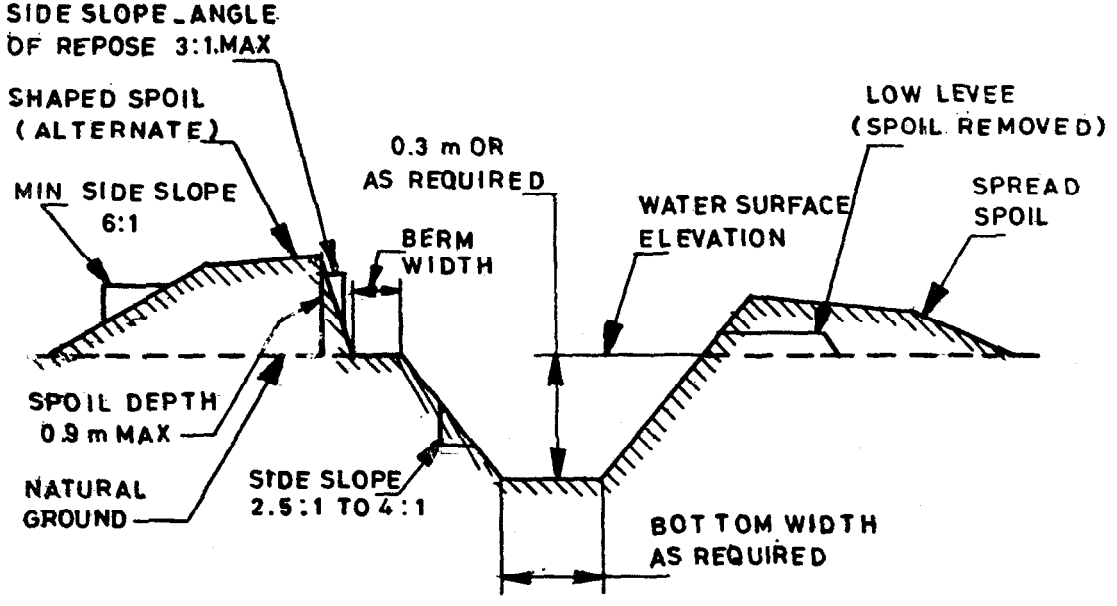


1D TRAPEZOIDAL FIELD DRAIN

FIG. 1 FIELD DRAINS



2 A VEE FIELD LATERAL



2 B TRAPEZOIDAL FIELD LATERAL

FIG. 2 FIELD LATERALS

TABLE 2 RECOMMENDED DIMENSIONS OF FIELD LATERALS

(*Clause* 3.3.6)

Sl No.	Cross Section/ Type	Depth, m	Recommended Side Slope	Minimum Side Slope
i)	Vee	0·3 to 0·6	6 : 1	3 : 1
ii)	Vee	0·61 and over	4 : 1	3 : 1
iii)	Trapezoidal	0·3 to 0·9	4 : 1	2 : 1
iv)	Trapezoidal	0·91 and over	2·5 : 1	1 : 1

3.3.3 The spoil from field laterals should, in most cases, be spread or removed. When spoil is removed, tillable low levees prevent water entry except at planned inlets. Spoil banks are usually recommended only as an undesirable alternate but may be preferred in some locations.

3.3.4 Shaped spoil banks should have side slopes on the field sides of 6 : 1 or flatter to permit operation of farm equipment. The area which contributes run off to the channel side slopes should be kept to a minimum for erosion control purposes. For this reason, sides lopes on the channel sides can be as steep as the angle of repose of the spoil material and should be no flatter than the channel side slopes. Shaped spil banks ordinarily should not exceed 1·0 m in height.

3.3.5 When spoil is shaped, berms may not be required. When used, berms should be adequate to satisfy the intended purpose and, in no case should be less than 0·6 m wide.

3.3.6 When spoil is dumped and left unshaped, the recommended berm widths are shown in Table 3.

TABLE 3 RECOMMENDED BERM WIDTHS FOR UNSHAPED SPOIL

Average Depth of Ditch	Minimum Berm Width*
m	m
0·6 to 1·2	Depth of ditch
1·3 to 1·8	2·4
1·9 to 2·4	3·0
Over 2·4	4·5

*In locations where soils are not stable, wider berm widths may be necessary.

3.3.7 Field laterals with their spoil can be hazardous, therefore side slopes, berm widths, etc, should be choosen to provide maximum safety in maintenance operations.

3.4 Farm mains shall be designed to carry the colume of flow indicated on the drainage curves. Where discharge into swamps, marshes or lakes is contemplated, high water marks shall be checked to determine whether gravity flow will be adequate. Pump drainage may be necessary. Specifications for the design and construction of farm mains usually require free board added to the design depths but are generally the same as for field laterals.

4. DESIGN FOR LAND SURFACE MODIFICATION

4.1 Land smoothing to eliminate minor depressions usually may be directed in the field without detailed surveys or plans. However, surveys may be required in critical portions of some fields when visual observations do not provide the accuracy required.

4.2 Land grading for drainage may be planned with row grades and cross slopes that are uniform or that vary within limits imposed by soils topography and economics. Areas to be graded shall be planned for a minimum number of field drains with the drains located, where possible, normal to field laterals and crop rows.

4.2.1 Surface drainage will be adequate if all reverse row grades that form depressions are eliminated. Minimum grade limits should include a tolerance in construction that will permit the elimination of all depression either in original construction or by post construction touchup. Reverse row grades can be eliminated with relative ease on fields designed with 0·2 percent minimum grades. Unusual precision in construction is required with 0·1 percent and flatter grades.

4.2.2 Land is frequently graded for both irrigation and surface drainage. In these cases, design limits to meet irrigation requirements may take precedence over those for drainage.

4.2.3 Economic considerations and the requirements for efficient mechanized operations may justify exceeding the recommended maximum row grade and cross slope limits. When the recommended limits are exceeded, provisions should be made to control erosion and sedimentation.

4.2.4 Recommended row grades range from 0·1 to 0·5 percent. Grades may be uniform, or increase or decrease.

4.2.5 Cross slopes normally should not exceed 0·5 percent. Reverse cross slopes are satisfactory provided field drains have the minimum required grades and drainage outlets are adequate.

4.2.6 Lengths of rows shall be determined by soil changes, soil depths, topography, irrigation and erosion control requirements, and grading costs.

4.2.7 The maximum allowable depth of cut depends upon soil and costs. Soil data shall be used for determining maximum allowable depth of cut.

4.3 Water levelling shall be planned to increase the size and improve the shape of the areas between contour levees. The conventional vertical spacing between levees shall be increased and levee alignment shall be improved. Straight, parallel levees are preferred.

4.4 Bedding shall be designed so that the beds are parallel to the direction of the greatest land slope. Field laterals oriented normal to the dead furrows should be spaced at interval that will provide adequate outlets.

4.5 Crowning shall be designed as precision drainage systems. Crowns may slope from the centre to both sides or in only one direction. Minimum cross slopes shall be 0 3 percent. Row drains shall be installed at all points where there are reverse row grades. Field drains or row drains are required at the ends of the rows. Field laterals shall be located parallel to the crowns to provide outlets for the row drains, and also normal to the crowns at intervals as needed to conduct flow to farm mains.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2